



Partial Translation of Extended Abstracts  
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High quality GaN film on low-temperature AlGaIn  
buffer layer grown with high growth rate

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1. Introduction A GaN layer on sapphire is generally grown on a buffer layer grown at a low temperature, and it is important to optimize conditions of the buffer layer and the GaN layer grown thereon for improving the characteristics of a nitride-based light-emitting device. This time we have found out that a high-quality GaN film can be obtained by remarkably increasing the growth rate for a buffer layer, and report this.

2. Experiment GaN was grown on ~~c-plane~~<sup>face</sup> sapphire by atmospheric pressure MOCVD in a two-step growth method. A buffer layer was prepared from AlGaIn, and growth temperatures for the buffer layer and the GaN layer grown thereon were 600°C and 1080°C respectively. The growth rate for the buffer layer



## Growth Conditions

### 1. Structure of MOCVD Apparatus

✓ 1-1. ~~Trilaminar~~ Horizontal MOCVD Apparatus  
*three layered flow*

1-2. Heating System by High-Frequency

Oscillation

### 2. Growth Conditions for AlGaIn Low-Temperature Buffer Layer

✓ 2-1. Substrate: ~~Sapphire C-Plane~~ Substrate  
*C-face*

2-2. Used Materials: TMAI, TMGa, NH<sub>3</sub>, H<sub>2</sub> and N<sub>2</sub>

$$\text{TMAI} / (\text{TMAI} + \text{TMGa}) \doteq 0.5$$

2-3. Growth Temperature: 600°C

2-4. Thickness of Grown Film: 120 to 140 Å

### 3. Growth Conditions for GaN Layer

3-2. Used Materials: TMGa, NH<sub>3</sub>, H<sub>2</sub> and N<sub>2</sub>

3-2. Growth Temperature: 1080°C

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## Structure of and Method of Evaluation for Evaluated Sample

### Structure of Evaluated Sample

GaN Layer (4 $\mu\text{m}$ )
AlGaIn Low-Temperature Buffer Layer (120 to 140 $\text{\AA}$ )
Sapphire <del>C-Plane</del> Substrate

*C-face*

### Evaluation Method

1. Full Width at Half Maximum in X-Ray  
Diffraction Rocking Curve

GaN(0002) Diffraction

2. Etch Pit Density

Etching Method NaOH:KOH = 5:1 (280°C)

3. Sectional TEM Observation

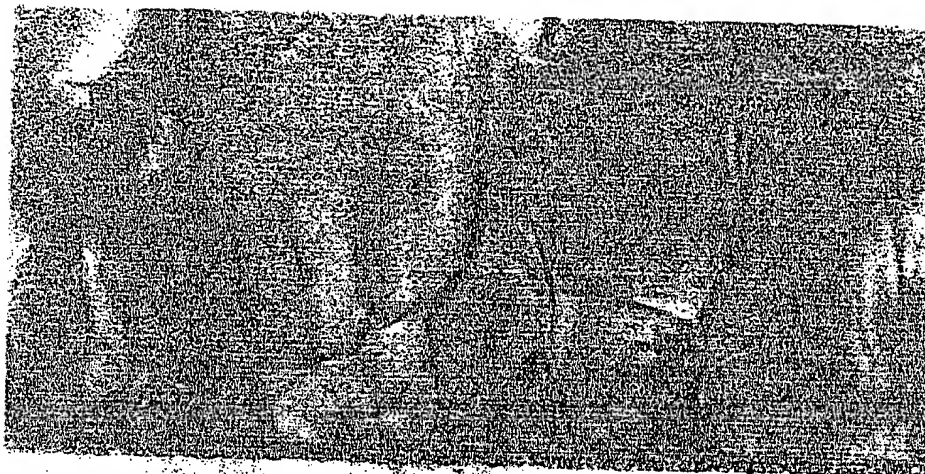
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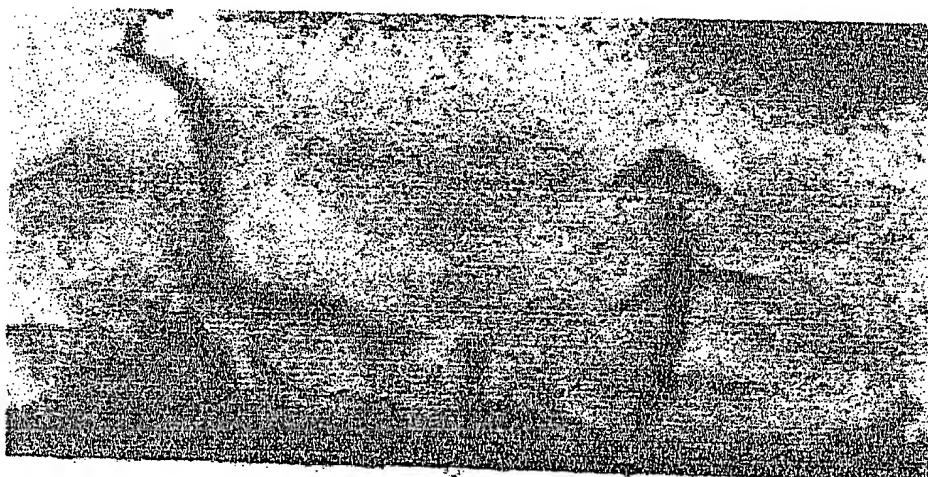
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*Observations of etch pits in GaN layers*  
(1) "~~Evaluation of Defects by Etch Pit in GaN~~" by Masayuki  
Hata et. al., Sanyo Electric Co., Ltd. Microelectronics  
Research Center

Extended Abstracts of the 57<sup>th</sup> Meeting of the Japan  
Society of Applied Physics (1996), No. 1, p. 302

0.2  $\mu$  m

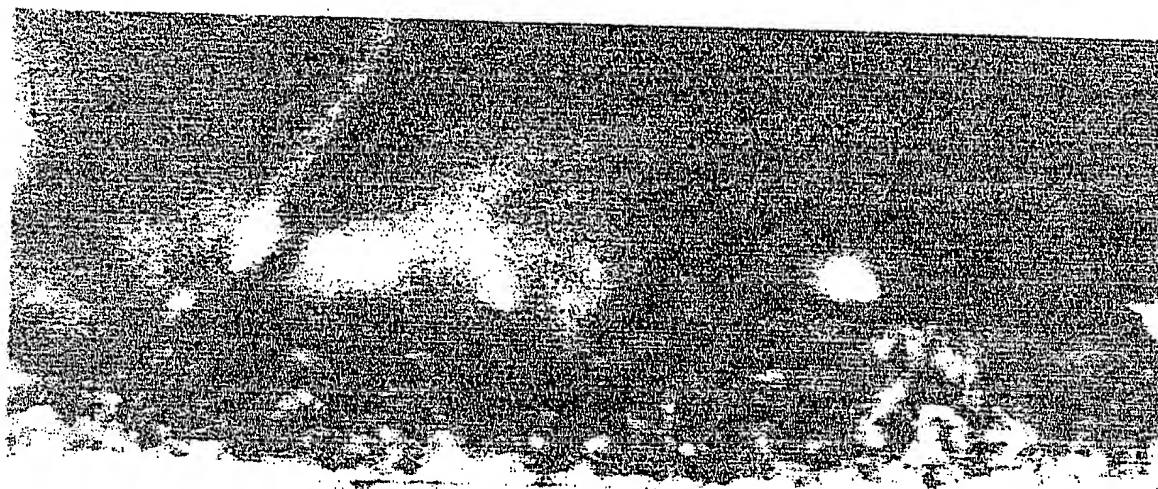
Growth Rate: 6.7 Å/sec.

0.2  $\mu$  m

Growth Rate: 25.0 Å/sec.

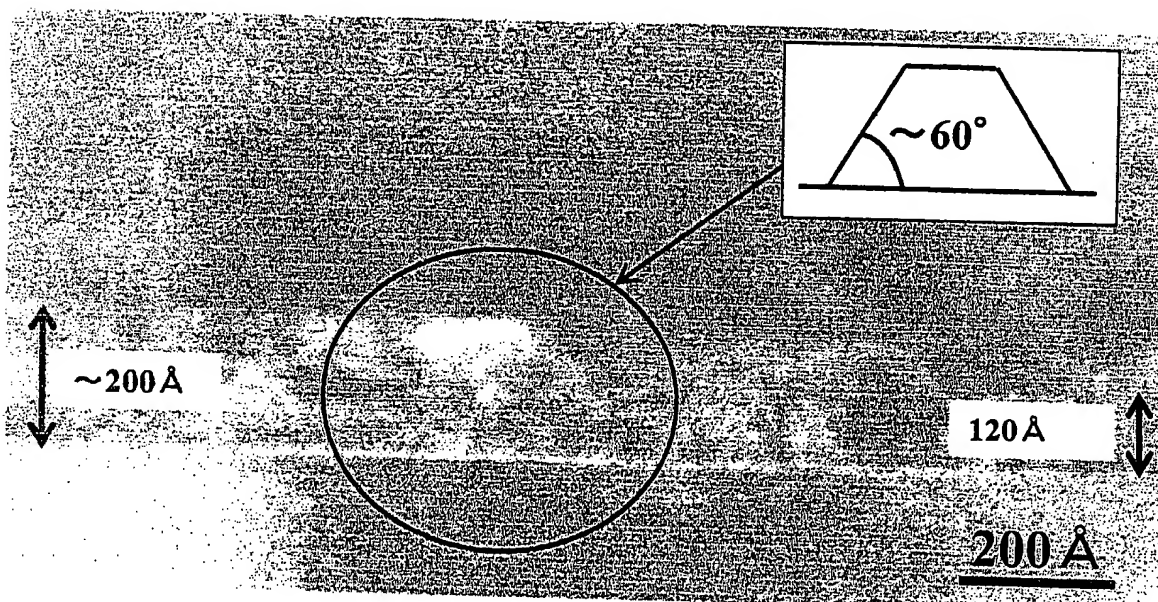
Sectional TEM Photograph of Interface Between  
Sapphire Substrate and GaN Layer ( $\times 300,000$ )

[Sectional Photograph on GaN (11-20) ~~Plane~~  
face



200 Å

Growth Rate: 6.7 Å/sec.



Growth Rate: 25.0 Å/sec.

- sectional TEM Photograph of Interface Between  
Sapphire Substrate and GaN Layer ( $\times 2,000,000$ )  
[Sectional Photograph on GaN (11-20) ~~Plane~~  
face

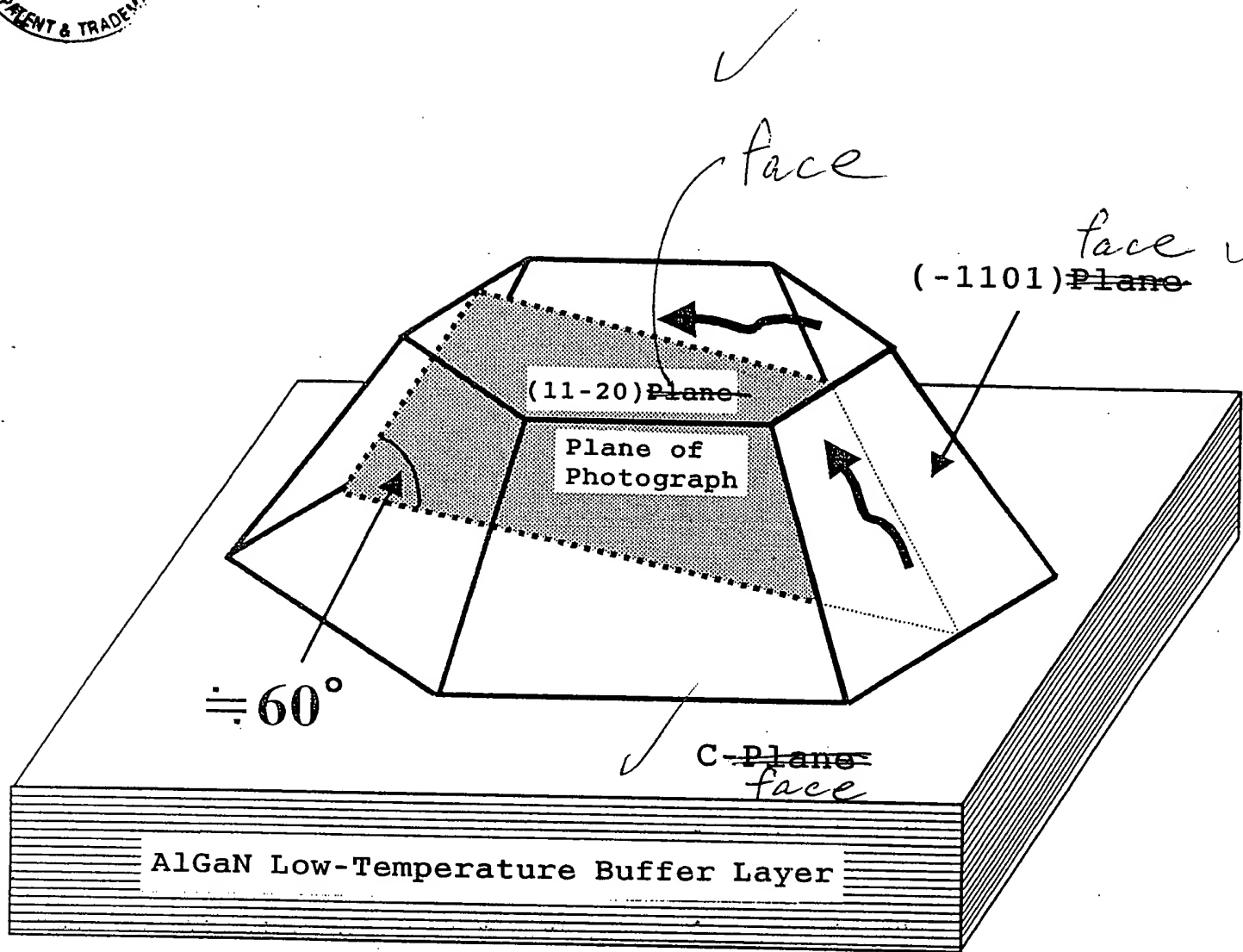


Image Diagram of Direction of Defect in Initial  
 State of Growth of GaN Layer Employing Fast-Grown  
 AlGaN Low-Temperature Buffer Layer



## Conclusion

1. Increasing growth rate of AlGaIn low-temperature buffer layer to 25 to 30 Å/sec.

### GaN Layer

- Full Width at Half Maximum of X-Ray Rocking Curve: 250 sec.

- Etch Pit Density:  $1.0 \times [10^9 \text{ cm}^{-2}]$



From sectional TEM on the interface between sapphire and GaN:

- ① Most of defects caused on the interface progress in directions parallel to the (-1101) ~~plane~~ and the C-~~plane~~.

*face*

*face*



- ② The number of through defects in the C-axis direction decreases.

2. A blue semiconductor laser of room-temperature continuous oscillation was obtained through high-quality GaN growth.